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Summary

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Article

« Tournesol et oléagineux dans les pays en développement » : le symposium de l'International Sunflower Association (Maputo, Mozambique, 9-12 février 1999)

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Au début du mois de février 1999, un symposium sur le tournesol et les autres cultures oléagineuses dans les pays en voie de développement s'est déroulé à Maputo (Mozambique). Les organisateurs en étaient l'International Sunflower Association (ISA) et la Faculté d'Agronomie de l'Université Eduardo Mondlane à Maputo.

L'organisation de ce symposium avait été décidée en juin 1996, lors de la dernière Conférence internationale du tournesol à Pékin, où les représentants des pays du Sud avaient manifesté leur souhait que les conférences scientifiques internationales prennent aussi en compte les contraintes et les attentes spécifiques des pays en voie de développement. Le symposium de Maputo fut donc conçu de façon à permettre un partage des expériences diverses sur la production des oléagineux annuels, principalement dans les pays d'Afrique tropicale. Des sessions de présentations formelles ont donc alterné avec des tables rondes sur des sujets cruciaux tels que la disponibilité en semences de qualité, l'organisation de filières, la mise en commun de l'information disponible à partir de cas concrets le plus souvent basés sur l'expérience mozambicaine du développement du tournesol en milieu villageois.

Avec une excellente organisation et une participation importante (environ 80 délégués représentant une douzaine de pays), l'intérêt de ce type de manifestation a été confirmé : qualité des échanges, intérêt des communications et des posters, diversité des expériences et des points de vue (les comptes rendus seront disponibles sous peu).

Si certains ont regretté une focalisation parfois trop forte sur le tournesol et le Mozambique, tous ont émis le souhait que ce symposium ait des suites, d'une part par le renouvellement de cette expérience, d'autre part en développant les possibilités d'échange et d'accès à la bibliographie internationale par l'utilisation d'Internet.

Increasing cotton oil production in developing countries : prospects from new technical practices in cotton growing[1]

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Abstract :
Although ranking among the major food oils in the world, cotton oil is basically a byproduct of cotton fiber production. Change in cotton oil production depends mainly upon change in seedcotton production, even if better oil processing from seedcotton would have positive impact as well. However, area devoted to seedcotton production in the world, including in developing countries to some extent, has been stagnating for decades while yield has also come to stagnate since mid-1980s. Increase in cotton oil production would derive mainly from seedcotton yield improvement which might, in some cases, induce positive change in cotton area.

The issue of modifying the current seedcotton yield trends demands to clarify reasons of yield stagnation being observed. Reasons differ among countries. In economically developed countries, yield is stagnating at a somewhat high level, existing high performing technical packages are fully applied and the challenge being set is to carry out new packages to enhance the yield potential. In developing countries where smallholder production dominates, reasons of yield stagnation at a low level are different so that new research outputs adapted to developed countries would not automatically be relevant in less favored countries.

It is now fully recognized that many technical practices being recommended to smallholders in developing countries are not relevant as regard these farmers' liquidity constraint and risk adversion while they are submitted to climatic hazards in addition to impediments in input and credit provision. Research work must then begin with taking into account these contraints in order to carry out new technical packages less demanding in cash expenses, more cost effective, providing better protection against climatic hazards and cotton pests. As in many developing countries, cotton is grown under rainfed conditions, tolerance to occasional drought is of major importance.

CIRAD has contributed to accertain that the above research objectives are not unrealistic. CIRAD has implemented the approach called "direct sowing over vegetative cover" during the last decade, either in commercial farming or smallholding farming. This paper states the principles of the approach, exposes the results obtained in Brazil and Madagascar and suggests the assumed phenomena that reverse a negative trend of soil degradation leading to yield unstability and profitability decrease into a positive process of soil improvement and higher input efficiency to ensure better profitability. Finally, relevance of experimenting the approach in Mozambique is discussed.

Key words :
cotton, cottonseed oil, Mozambique, Brazil, Madagascar, no-tillage, direct sowing under vegetal cover, developing countries, sustainability, soil degradation, commercial farming, smallholder farming.

1. Communication to ISA Symposium, Maputo Feb. 9-12, 1998: "Sunflower and other oilseed crops in developing countries".

Introduction

Although ranking among the major food oils in the world, cotton oil is basically a by-product of cotton fibre production. Many factors could impact on cotton oil production in developing countries, but change in seedcotton production accounts for the most. However, area devoted to seedcotton production in the world, including in developing countries to some extent, is stagnating for decades while yield has also come to stagnate since mid-1980s. Increase in cotton oil production would derive mainly from seedcotton yield improvement which might also, in some cases, induce positive change in the cotton area. The issue of modifying the current seedcotton yield trends demands to clarify reasons for yield stagnation being observed. Albeit reasons differ among countries, cotton research has to address a challenge, either to set yield potential beyond the current level in developed countries, or to carry out new techniques more accessible and suitable to smallholders' production constraints in developing countries. In the case of smallholding production, climatic hazards, limited labour availability as well as lack of capability to access to costly inputs are among the major impediments to cope with.

There are now experiences showing that direct sowing under vegetal cover could be a promising answer. In the short term, it favours water retention in the field helping then to face drought occurrence, therefore providing better fertilizer effectiveness while it could also save labour at soil preparation and weeding stages. In the mid-term it prevents the soil from eroding preserving it from the current process of degradation. Experiences, still too limited in Africa, have been engaged at commercial farming and smallholding cotton production schemes, both existing in Mozambique. There is room to foresee the implementation of these new techniques in this country.

Cotton oil production : still high but relatively loosing ground

Except in cotton producing countries, cotton oil is seldom known, basically because this oil is little subject to world exchange. This is a pity as cotton oil is special through its quality for cooking uses, it is particularly recommended either for salad dressings or for frying purposes. It is also a high quality oil in nutritional terms, having a high content in a component that leads to the production of vitamin E (it is assumed that a spoon of cotton oil can provide as high as 9 times the daily need in this vitamin) while the ratio of essential amino-acids to total amino-acids is close to that of soybean oil (36.4% compared to 39.9%).

Table 1. *Variability of cottonseed oil content among part of CIRAD cotton germplasm.*

	Oil contents reported to dry and delinted cottonseed			
	16,0-19,9%	20,0-23,9%	24,0-27,9%	28,0-31,9%
% of cultivars	3,0	29,1	62,2	5,6
Number of cultivars	35	332	709	64
Total number of cultivar	1140			

Cotton oil production is estimated at around 4 million tons in 1997-98, it is accounting for 11% of the total world production of food oil, ranking then at the sixth or seventh position along with peanut oil. The production achieved today has resulted from a dramatic increase as, in 1961-62, production was only assessed to be 2.5 million tons. This increase has been unsteady during this period of four decades, annual growth rate has decreased from 11% till 1972-73 to only 4% till now. This reduced growth rate has induced a widening gap between cotton oil and the first ranking oils.

Compared to the major food oils, the volume of cotton oil subjected to international trade is weak. In 1997-98, such trade has concerned 250 000 tons, only 6% of the whole food oil trade. Most countries have devoted their production to their internal trade, this is the case for China, not mentioning the cases of minor producing countries such as African countries. The major exporting countries are the United States, accounting for 56% of the market share, followed by Argentina (20%) and Brazil (14%) while the countries of destination are mainly Egypt, Salvador, Japan, South Korea or Mexico.

Compared to the major food oils, cotton oil is enjoying a substantially higher price. In average, cotton oil price has fluctuated between US $545 to 750 per ton (CIF Rotterdam) while soybean oil price has ranged from US $160 to 235 during the last five years. Although an increase in cotton oil offer on the world market could lead to a price decrease, price could be considered as a serious incentive to promote cotton oil production. It therefore does make sense to analyse what the factors are controlling this production.

Numerous factors controlling production but of unequal scope for action

Factors having a potential impact on cotton-oil production are numerous, they pertain to the industrial area or the agricultural area. The cottonseed production is not totally processed, it can happen that cottonseeds are simply burned, or used as manure. In other cases, cottonseeds are used directly as animal feed. Cottonseed processing could however sound un-economical if transportation cost to the oil extraction plant is too high, this is the case in many developing countries with long distances and insufficient road networks. In Mozambique, we were informed in 1995 that there was only one oil extraction mill operating but located in Beira while cotton production came mainly from the northern part of the country. In 1997/98, it is estimated that only 26 out of 34 million tons of cottonseeds have been processed in the world. An exhaustive processing of cottonseed would induce a dramatic increase in the cotton oil production in the world. Such a situation could become real as many countries have come lately to this processing: in most French speaking countries in Africa, such processing has started mainly at the beginning of the 1980s. However, this factor is beyond the scope of research scientists.

Still in the industrial field, there are technologies that extract more or less completely the oil contained in cottonseed. Crushing associated with extraction by solvent helps to reach a better extraction ratio, but this technology could sound too costly for some countries. Therefore, improving the extraction performance at an acceptable investment cost is another positive factor to cotton oil production in the world. The world oil extraction ratio is evaluated at 15,4% of cottonseeds, there is a significant gap between this ratio and the oil content of cottonseeds. This factor is however related to the investment capacity, this is also beyond the scope of agricultural scientists.

Oil content could be reported to cottonseed with linter, to cottonseed without linter or to the cottonseed nut. An oil content of 21% reported to raw cottonseeds with linter means roughly content of 37,5% reported to the cottonseed nut. Commonly speaking, it is usual to express oil content to the raw cottonseeds whose mean value is assessed at 20-22%. Increase in the oil content of cottonseed is a realistic way to reach the target of increasing

Table 2. *An example of simultaneous increase of fibre and oil yields in Côte d'Ivoire.*

Variety	Allen	L 299-10	ISA GL7
Year reference of adoption period	1966	1981	1991
Seedcotton yield (kg/ha)	926	1086	1250
Fiber yield (kg/ha)	366	452	575
Cottonseed yield (kg/ha)	514	580	613
Ginning outturn (%)	39,5	41,6	46,0
Oil yield (kg/ha)	108	122	129
Protein yield (kg/ha)	108	122	129

Source : J. Lançon, 1993.

cotton oil production. There is evidence that one may make use of the genetic variability for such a purpose (*table 1*). Chemical analyses made on part of the CIRAD cotton germplasm show that over 60% of the varieties have an oil content of 24.0-27.9% reported to dry delinted cottonseeds (or around 21.6-25.1% reported to cottonseeds with linter). However, there is a significant part of the varieties showing an oil content over 28.0% (or 25,2% reported to cottonseed with linter) while there are also varieties of very low oil content. Nevertheless, making use of high oil content has seldom occurred so far, basically because fibre is the main purpose of cotton production and criteria for cotton breeding have always been set for seedcotton and fibre production. It is unlikely that this situation will change.

Furthermore, focus on fibre production could lead to decrease the cottonseed production and as a consequence to cotton oil production reduction. Many countries have achieved a dramatic increase in the ginning outturn at the expense of the cottonseed production. While the average ginning outturn in the world is around 38%, there are varieties achieving very commonly 42-44% and even up to 47%, adoption of such varieties in Francophone African countries has for instance led to a regional mean ginning outturn of 42%. Other things being equal, this achievement is opposed to cotton oil production increase although this is economically sound. We do not claim however that improvement of cotton fibre yield is necessarily not compatible with higher oil production. Provided that seedcotton yield is improved along with ginning outturn, oil production could be increased as well, as this has been achieved in Côte d'Ivoire (*table 2*).

The case of Côte d'Ivoire underlines that the only factor remaining within the scope of the agricultural scientists is to increase seedcotton production. In spite of what has been achieved so far, this increase still sounds as a critical challenge for scientists under the current socio-economic situation. As cotton hectarage has become stable for a long period at the world level, seedcotton production increase depends upon yield increase while such yield is stagnating if not decreasing, in particular in developing countries.

The challenge of moving out a negative process of yield stagnation

A negative trend calling for adapted production techniques

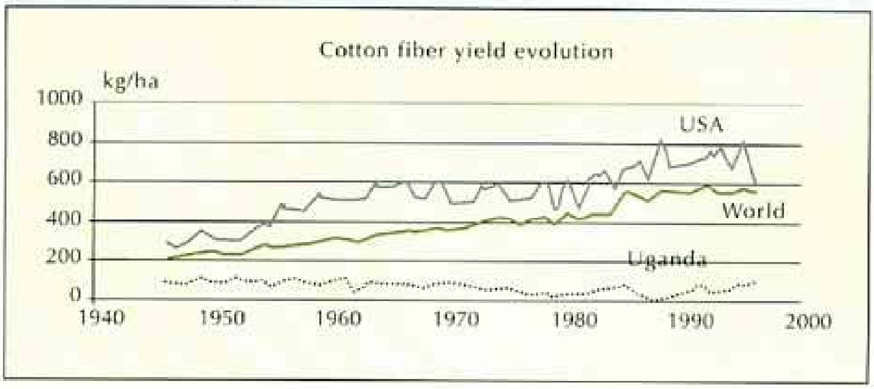
At the world level, seedcotton production has continually increased although at a stable annual growth rate of 2,3% since 1950s, thanks to a bit higher rate in developing countries even if such a growth could be very diverging within each economic group. Within the group of developing countries, a positive production trend in French speaking African countries is rubbed out by a negative trend in eastern and austral Africa.

The cotton acreage has remained stable around 33-34 million hectares for three decades. This stability is encountered in developed as well as in developing countries although the same diverging trends are observed within each group of countries.

The most worrisome fact pertains to the phenomenon of cotton yield stagnation in the world. This is true either in developed countries or in developing countries although at a different yield level (*figure 1*). Furthermore, instead of the only stagnation, there is evidence that yield is decreasing in many developing countries in spite of the low yield level being achieved so far. The issue is then to reverse a yield negative trend, but this implies firstly to understand the reasons for such a trend.

Reasons for the cotton yield stagnation or decrease are of course different from one economic group of countries to another, if not from a singular country to another. Focusing on the special case of developing countries, there are many research works that have enlightened the reasons for the weak yield level and its negative evolution. In a nutshell, low yield is associated with the limited use of chemical, mainly fertilizers and pesticides. There are many interacting factors that discourage input use. The insufficient level of the seedcotton price used to be presented as the main discouraging factor, under this perspective, some observers claim that improving the seedcotton price would automatically reverse the existing trend of weak yield and production. This position is seriously discussed by those people who emphasize on the specific smallholders' socio-economic behaviour and environment in developing countries. Improving the price of seedcotton has no effect on the fact that chemical inputs could not be accessible to smallholders, either physically (lack of procurement network, timely provision of product of relevant quality...) or financially (reasonable cost, credit availability). It has neither any effect on lack of information on input use and effectiveness. There are also objective reasons for smallholders to feel some lack of confidence in the chemical input effectiveness, this is a serious impediment for their use. This is the particular case of chemical fertilizers whose impact depends upon climatic conditions, spe-

Figure 1. *Stagnation and decrease of cotton fibre yield.*



Appendix 1. *Occasional negative mechanisms for short term profitability and long term sustainability associated to conventional production techniques.*

Events involved	Effects on water use	Effects on soil physics	Effects on soils biology	Effects on organic matter status	Effects on nutrients status	Effects on production profitability	Effects on production sustainability	Effects on global environment
Water run-off	non-optimal water use	increasing soil erosion					enhancing soil degradation	sustaining new forest clearing
High organic matter mineralisation		decrease soil porosity, structure increase susceptibility to soil erosion	reduction of macrofauna, microfauna and microflora activities	decrease o.m. content	decrease of nutrient fixation	decrease of response to fertilizers profitability decrease through lower yield or higher input costs	enhancing soil degradation	sustaining new forest clearing enhancing greenhouse effect
Nutrient leaching					decrease of nutrient status	increase of need of fertilizers		increase of water pollution by chemicals

cially in locations where there is a risk of drought occurrence. Farmers do take this occurrence into account, this is why they find some rationale to apply fertilizers lately, even beyond reasonable delay, spreading for instance fertilizers at the most rainy period with a high leaching ratio. Briefly speaking, an yield increase could derive from higher chemical use if such an use could be made more secure under climatic risky conditions.

The need to move forward a new production technique paradigm

Intensive agriculture with conventional techniques still widely applied in the world has contributed largely to the agricultural production augmentation, hence trying to address the limitation of such agriculture is not to deny its impacts on better insuring food security since World War II. There is however no reason that the same production techniques must last forever while the world is evolving and that the humankind is paying more attention to a wider range of concerns. One among these concerns pertains to the issue of sustainability that has not been clearly taken into account. Besides, most intensive agricultural techniques have been carried out in locations where climatic features and namely climatic risks are quite different from those encountered in tropical developing countries.

Even in developed countries, conventional intensive agriculture is being revisited because it relies upon a paradigm which deserves to be questioned. Basically, the current dominant paradigm relies on the assumption that the plants which are grown for the economic purpose are most efficiently favoured if they are get rid of any competition from other plants of the natural vegetation. In other words, the natural vegetation is seen as an enemy to eradicate and it could not be in any sense regarded as a possible ally. Such a paradigm has led to technical practices devoted to keep only economic plants on cropped fields. So, soil is ploughed partly to air the soil and preserve its structure and partly to bury weeds that have developed. Doing so, one is also putting upward weed seeds which then benefit from favourable conditions for germinating and infest the field. To prevent the competition of such weeds, either selective herbicides are used shortly after sowing or mechanical weeding is implemented later on. All these operations have helped reach higher yield, but they are costly in terms of energy consumption, equipment, time and labour. More questionable is that, under some circumstances, like under an aggressive rainfall, yield increase cannot be preserved owing to soil degradation through erosion or owing to susceptibility to seasonal drought. Furthermore, the more soils keep on degrading the less the high investment in soil preparation and in keeping it free of weed competition is paid back. It is like entering a vicious circle, and one way of getting out of it is to question the basic assumptions that have led to it. In short, the issue is finding out and follow a more promising paradigm.

The best way of producing an economic crop either in the short or long run may not be to keep it out of the presence of any other plants. Sound exploitation of nature does not mean necessarily ignoring plants of the natural vegetation. Taking care of soil evolution in the positive way, sheltering it from erosion, insuring the process of organic matter status could improve the efficiency of the chemical inputs being used, if not with decreasing dosages, or could insure such efficiency even under climatic hazards like drought occurrence.

The approach of questioning the conventional paradigm of tillage has been more or less complete. Very often, the concept of no-tillage has been based upon more or less exclusively on the labour and energy saving while the concern of inducing a more sustainable process of soil organic matter management is not always clear. During the last three decades, there are experiences being implemented more or less isolately, at more or less great scale, turning the back, more or less explicitly, to the conventional paradigm. Modalities of operating the new paradigm as stated could be very diversified, likely in the future, new and better performing techniques could be carried out. One promising package of modalities is gathered under the concept of direct sowing under vegetal cover. The United States have played a pioneer role in adopting such techniques that have spread dramatically in Southern America. CIRAD has also played such a role in implementing the new techniques in tropical countries during the last decade.

Induced change into more sustainable soil evolution mechanisms

In the tropical conditions, either under excessive or limited rains, conventional technical practices involve mainly negative soil evolution mechanisms. Basically, these practices lead to cropped soil which are left mainly naked conducting then to an open crop/soil system. This system is open to water run-off, it is open

Appendix 2. *Positive mechanisms for production profitability and sustainability associated to direct dowing under vegetal cover.*

Events involved	Effects on water use	Effects on soil physics	Effects on soils biology	Effects on organic matter status	Effects on nutrients status	Effects on production profitability	Effects on production sustainability	Effects on global environment
Water retention	better water use						soil erosion control	alleviate need for additional forest clearing
Higher biomass production		improvement of soil structure	more macrofauna, microfauna and microflora activities	higher level of humification continuous feeding of o.m. capital	higher fixation of nutrients	Better response to nutrients, fertilizers better tolerance to climatic hazards due to better soil	soil quality being maintained if not improved	
More developed root system					reduction of nutrient leaching	limiting need to chemical fertilizers		reduction of water pollution by chemical fertilizers
Deeper root system					recycling leached nutrients	limiting need to chemical fertilizers		

to organic matter and nutrient losses. Water run-off is a factor of soil damages. Loss in organic matter is harmful to soil organic matter status which has serious and negative implications on soil biology and structure. Nutrient loss, mainly from leaching, is responsible to soil becoming less fertile, then requesting higher compensation, to some extent, by more input of chemical fertilizers. More detailed mechanisms involved are presented in the *Appendix 1* where effects are catagorised according to their impact on the soil physics, biology and chemistry, all these impacts may decrease the crop profitability or the production sustainability or both. Water run-off is a threat to soil erosion. No compensation of organic matter consumed through heavy mineralisation leads to decrease organic matter content, which reduces soil biological activities conducting then to worse soil structure. Soil evolves into a degrading process rending the crops more susceptible to climatic stresses. Organic matter decreasing status means less nutrient fixation, then lower response to chemical fertilizers or higher need for such input, impacting negatively on the crop profitability. In short, the mechanisms briefly described are harmful to the production sustainability in the long run and to the production profitability in the short run. A higher level of concern pertains to the negative impacts on the global environment, through water and soil pollution, enhanced forest clearing and CO2 liberation that sustains the greenhouse effect.

Targeting at reversing the negative mechanisms being pointed out demands to cope with the basic events at their origin, namely water run-off, losses in organic matter and nutrient status. In other words, there is need to look for a crop/soil system that is less open, if not closed, and that allows sustainable recycling of organic matter and nutrients.

The Direct sowing under vegetal cover provides a way to move towards such a system. The detailed mechanisms are presented in *Appendix 2*. The vegetal cover allows better water retention and prevents soil erosion. A better water use is positive for higher biomass production whose humification favours maintaining if not improving the organic matter status of the soil, beyond only compensating the losses through the excessive mineralisation under tropical

Table 3. *Particular issues to address according to the rainfull level in tropical conditions.*

	Humid tropical areas	Dry tropical areas
Water management	Excessive rains	Soil erosion by water run-off Water deficiency Root development beyond 60 cm detph
Biomass production management	Weed production control	Difficulty in enhancing live biomass production prior to crop production
Soil physics management	Soil compaction related to mechanical land preparation	Sealing of soil porosity
Soil chemistry management	Aluminic toxicity Soil acidification Excessive nutrient leaching	
Sowing management		Short sowing period

Table 4. *Production costs and profitability according to technical approaches in Brazil.*

All cost in US	Early				Late	
	Monocropping		Direct sowing		Conventionnal	Direct
	Fazanda Recanto 1	Fazanda Recanto 2	Fazanda Recanto 1	Fazanda Recanto 2	Fazanda Canada	Fazanda Canada
Hectarage	25	20	25	20	25	25
Costs before sowing	116	112	29	73	112	93
Costs for sowing	140	142	113	124	155	122
Costs during growing phase	379	457	399	442	349	396
Total costs before harvest	636	712,39	542	641	617,5	612
Costs for harvest	211	181	279	262	205	233
Transportation costs	20	22	27	32	25	29
Management costs	193	160	193	160	160	160
Total costs	1061	1077	1042	1097	1009	1035
Seedcotton yield (kg/ha)	2073	2190	2736	3170	2490	2829
Gross revenue	925	1248	1222	1806	1422	1616
Net margin	135,4	171,1	179	709	412,9	580

conditions. Better organic status is favourable for nutrient fixation which means higher response to fertilizers being used. Through a rational combination of the crop and the species to provide vegetal cover, a more developed and deeper root system is achieved which is favourable to reduce nutrient leaching and to recycle those nutrients that have leached, preserving if not improving the chemical fertility of the soil. Globally speaking, sustainability could be achieved through the preservation of the soil capital while crop production profitability could be improved through fertility maintenance and tolerance to climatic stresses.

The mechanisms involved in tropical conditions as described are general features that have to be fine tuned according to the rainfall level. In humid tropical areas, some mechanisms to be emphasized are different from those more relevant for dry tropical zones. We have briefly summarized in *table 3* the specific mechanisms or issues to address in particular in each situation.

CIRAD experiences of direct sowing under vegetal cover

The approach of direct sowing under vegetal cover lies upon three simple principles :

1. Not to till the soil.
2. Keep the soil covered with vegetal material as long as possible.
3. Implement direct sowing through the vegetal cover.

Following the mentioned principles, CIRAD has got some promising results in two very diverging situations. In Brazil, CIRAD has been involved on a big scale commercial farming subjected to a long and exceedingly rainy season, in the States of Goias, Mato Grosso and Sao Paulo where the average rainfal is around 1500 mm. In Madagascar, CIRAD has been associated in smallholding production at a location with only 500-600 mm of rainfall.

In Brazil, CIRAD expertise has been requested by a big agricultural business to set up a new production process in order to correct the damage (severe soil erosion and yield decrease) from several years of conventional farming by mono cropping and land preparation with discus plough. Evolving from mono-cropping to cultural rotation has provided first positive results dramatically strengthened by the implementation of direct sowing under vegetal cover. The vegetal cover has been obtained through various procedures. One way is to go through live vegetal covers with adapted species of Braccharia, Crotalaria...Another way is to proceed by dead vegetal covers. These covers could correspond to crop residues of cereal crops. Most performing dead covers have been obtained through crops, cereal or legumes, specially grown at the beginning of the rainy season and whose biomass is controlled by chemical herbicides. Sorghum or millet have provided abundant and effective biomass for the sought purpose.

The agronomic and economic results achieved

Table 5. *Cotton production costs prior to harvest according to technical approaches in Brazil.*

All cost in US $/ha	Early sowing				Late sowing	
	Monocropping, conventional techniques		Direct sowing under cover		Conventional cropping	Direct sowing
	Fazenda Recanto 1	Fazenda Recanto 2	Fezanda Recanto 1	Fazenda Recanto 2	Fazenda Canada	Fazenda Canada
Hectarage (ha)	25,0	20,0	25,0	20,0	25,0	25,0
Costs for pre-sowing & sowing	**256,8**	**255,1**	**142,9**	**198,5**	**268,1**	**215,7**
Seeds and sowing	33,5	33,0	45,3	40,9	32,6	52,7
Land preparation	116,7	106,8			107,0	
Herbicides	38,2	31,5	29,2	43,7	44,7	49,1
Fertilizers	68,4	83,8	68,4	113,9	83,8	113,9
Cost for development phase	**379,2**	**457,6**	**399,8**	**442,8**	**349,4**	**396,4**
Mechanical weeding	71,7	61,4	33,6	10,4	27,9	8,8
Herbicides	57,9	50,2	116,6	86,4	75,2	141,3
Insectisides	181,1	249,6	181,1	249,6	163,4	163,4
Fertilizers	68,5	96,4	68,5	96,4	82,9	82,9
Total costs before harvest	**636,0**	**712,7**	**542,7**	**641,3**	**617,5**	**612,1**

Source : L. Séguy *et al*, 1998.

Table 6. *Yied and profitability of cotton growing according to technical approaches in Madagascar.*

		Andranovory site			Ankozoaba site		
		Cottonseed yield (kg/ha)	Gross margin (FM/ha)	Income FM/Man.Day	Cottonseed yield(kg/ha)	Gross margin (kg/ha)	Income FM/Man.Day
Conventional plough	Recommended NPK dosage	797	529	5,1	750	257	2,7
	1/2 NPK dosage	500	156	1,7	655	307	3,3
	Average	649	343	3,4	703	282	3,0
Direct sowing	Recommended NPK dosage	1954	2927	28,6	1220	1145	14,0
	1/2 NPK dosage	1613	1758	19,2	920	785	10,8
	Average	1784	2343	23,9	1070	965	12,4

Source : D. Rollin, 1998.

are quite convincing. In spite of erratic rainfall, yield has been better than experienced previously, while production costs have decreased, insuring then better profitability. Labour saving and reduction in energy consumption have led to effective cost diminution.

For the 1996/97 season, costs and profitability have been assessed at three locations, on great scale of experiment plots of 20-25 hectares each, either with early or late sowing. Cotton rotating with soybean + millet directly sown under vegetal cover has been compared to mono cropped cotton installed by conventional techniques of deeply ploughing. In any of the three cases, yields achieved by direct sowing under vegetal cover have been systematically higher with lower production costs before harvest. Costs from sowing to harvest may be higher for direct sowing under vegetal cover as higher yield leads automatically to higher harvest costs. In situations of early or late sowing, net margin increase has been spectacular (*table 4*).

According to the technical approaches being tested, production costs differ mainly in the sowing and development stages. In any of the three cases, costs at pre-sowing and sowing are significantly lower for direct sowing (*table 5*). The same applies for the costs related to the development stage, except in the case of late sowing. Cost reduction comes from suppression of land preparation.

There is little difference for herbicide costs at the pre-sowing and sowing stage. At the development stage, the suppression of the mechanical weeding, either motorized or manual, is another source of cost reduction, this is however compensated by substantially higher herbicide costs although this is critical to achieve effective mulch protecting against soil erosion and sheltering from the effects of seasonal drought. The chemical control of the weeds at this stage appears to request the highest technical command. We can assume that there remains room for improvement that will help reach even better profitability. Of course, another critical issue is controlling disease outbreaks when cotton is directly sown, this could be fairly addressed by seed treatment with the right products. After few years of experimenting the new techniques, the Brazilian agribusiness is deciding to move forward applying them on all of its farms. In Madagascar, with smallholdings in locations of limited rainfall, dead cover has provided the most acceptable results. Because of short rainy season, there is no possibility of obtaining a biomass production for the cover purpose before installing the economic crop. The dead mulch of crop residues or bush grasses is imported manually to the field plots.

Results achieved in farm level demonstration plots are very positive towards conventional land preparation by ploughing, in terms of yield levels, profitability and labour saving although the relative advantage of the direct sowing under vegetal cover has varied according to the experiment locations.

Results obtained under conventional ploughing have been very close for the two locations, systematically far lower than under the direct sowing with vegetal cover. It is observed a substantial yield gap between the two locations under direct sowing, meaning that this technical approach helps to take a full advantage of any better growing conditions (*table 6*). In other terms, there is some evidence that direct sowing provides some guaranty to insure yield at a confortable level. Owing to higher yields, gross margins with direct sowing under vegetal cover are 3 to 7 times as high as those obtained by conventional ploughing, the same with the remuneration of the family labour (*table 7*).

The impact of the direct sowing under vegetal cover on labour saving is less obviously shown as the labour is counted for the whole cycle, any increase in yield automatically induces more labour during the harvest phase specially in the case of handpicked cotton. At the location of Ankazoabo where the yield gap has been smaller, such a positive impact appears very clearly. Positive social impacts at the village level deserve also to be emphasized. Farmers achieved rapidly to some command in the implementation of the new techniques, they realize very quickly that the vegetal cover needs to be thick enough to protect soil, maintain soil humidity and impede weed development. They realize also that covered fields demand to be protected, so they rapidly set up collective rules to have the concerned plots out of reach of animal wandering and bush fire damages.

Positive results obtained in Brazil and Madagascar confirm the potential promises of the new techniques, however we are still far from suggesting extrapolating them to other situations. Indeed, if principles guiding the approach of direct sowing under vegetal cover are very simple, their implementation in practice could however raise some difficulties and techniques have to vary according to the local climatic, sociologic and economic situations. Techniques suitable to excessive rainfall and long rainy season giving abundant biomass production are not relevant for locations with a short rainy season, or subjected to the risk of seasonal drought. Mulching by vegetal cover could be live mulch for which the competition with the main crop has to be properly managed. It could also be dead mulch, coming either from a previous live mulch properly controlled by adapted chemical herbicides or artificial mulch obtained through straws imported from

Table 7. *Labour according to technical approaches in Madagascar.*

	Plough		Direct sowing under cover	
	Yield kg/ha	Man.Day/ha	Yield kg/ha	Man.day/ha
Andranovory	797	165	1954	158
Ankazoabo	750	202	1220	82

Source : D. Rollin, 1998.

the bush or other plots. It is clear that the way to obtain the needed mulch should be compatible with rainy season length or equipment or labour availability. The species to be used as live mulch should provide some additional economic interest to facilitate their acceptability for farmers. In countries where husbandry is developed, likely species that could provide cattle fodder should be favoured.

There are reasons to expect that even better results could be achieved through an optimal exploitation of the interaction between the new cultivations techniques and adapted genotypes as well as adapted pest management program. Indeed, the most performing varieties under direct sowing could be different from those bred for conventional techniques.

Conclusion : prospects for Mozambique

Mozambique has a good potential for cotton production in terms of land availability and soil quality. The highest production has been obtained in 1974, with regard to the production trend since 1992, it is realistic to expect to set up new production record very quickly, provided that several constraints will be alleviated.

Cotton is currently produced through three complementary systems : production by smallholdings of several hectares, production by small agribusiness called "privados" at the head of several tens to several hundreds of hectares, and finally direct farming of joint venture firms who enjoy the right of exploiting ten to hundred thousands of hectares. There is evidence that conventional cultural techniques are not sufficient to insure direct farming profitability, so that direct farming is being implemented only at a very marginal part of the land allocated to. The same applies to the land owned by the "privados" farmers. More effective production techniques will automatically lead to more land devoted to cotton production. There is then an expectation for new cultural techniques that needs to be met.

For the smallholding production, there are plenty of constraints that impede cotton production. Input and technical information provision are still far from being optimal, this is an issue of the input distribution network associated with credit provision in cotton production areas isolated from main economic centres. High performing varieties with seeds properly produced and distributed are not insured in every cotton zone. The most important constraint to solve is probably the occurrence of occasional drought that discourages investing in chemical inputs as cotton production is essentially non-irrigated. It is possible to claim that this third constraint is the most critical, as securing against occasional drought will push to use commercial seeds of adapted and highly performing varieties and chemical inputs, therefore encouraging private operators to provide them. There is then also rationale experimenting the techniques of the direct sowing under vegetal cover for this production scheme in Mozambique.

For the three production schemes, application of new cultural practices following the new technical paradigm could help promote seedcotton production and hence cotton oil production. However, it is likely that the same principles of direct sowing under vegetal cover will give rise to diversified cultural practices in the three different production systems for which an adaptive research program should be implemented. Besides, in the prospect of an efficient and smooth transfer to the smallholders, a participatory approach should be set up from the experiment stage.

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A C T U A L I T É

Études Fleurbaix Laventie Ville Santé

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Les résultats de l'étude « Fleurbaix Laventie Ville Santé I », le lancement de « Fleurbaix Laventie Ville Santé II » et la création de l'Observatoire des habitudes alimentaires et du poids ont été présentés à la presse le 25 mars 1999. Rappelons que l'opération « Ville Santé » a été menée dans deux villes du Nord-Pas-de-Calais : Fleurbaix (2235 habitants en 1995) et Laventie (4426 habitants), ces villes ont été choisies en particulier pour la stabilité de leur population et leur jeunesse (60 % environ des habitants ont moins de 40 ans).

Cette opération a été réalisée dans le cadre de l'Association « Fleurbaix Laventie Ville Santé » créée en 1992 et présidée par le Professeur Pierre Fossati (CHU de Lille). Cette association s'est dotée d'un Conseil scientifique indépendant dirigé aujourd'hui par le Professeur Pierre Ducimetiere (INSERM 258). Les actions sur le terrain sont coordonnées par le Docteur Jean-Michel Borys.

L'étude « Fleurbaix Laventie Ville Santé »

L'étude « Fleurbaix Laventie Ville Santé I » lancée en 1992 et réalisée sur plus de 5 ans a constitué une vaste enquête alimentaire visant à préciser l'influence des habitudes alimentaires sur l'apparition des maladies métaboliques.

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